Active Interferometric Measurement and Algorithmic Correction of Vibration-Induced Fluctuations in Distance Between Arrayed Antennae in Phased Array RADAR

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Introduction

Phased Array RADAR units such as the X-Band RADARs used by the Navy operate according to the principle of beam-steering in which control over the relative timing of emissions from neighboring antennae along a flat array can be used to direct beams in a desired direction. This system has limitations which are rooted in both manufacturing irregularities in terms of the shape, size and relative placement of the antennae relative to one-another and; even more problematically; vibrations as minute as the nano- scale which influence the distance between the antennae which, in turn, affects the orientation and scope of the beam emitted by the phased array.

Improved manufacturing precision in the size, shape and relative placement of the antennae coupled with an active vibration measurement system based upon interferometry can allow for a dramatic improvement in both range and blur-prevention in 3D mapping of detected objects used for object classification.

Abstract

Deviations on the nano- scale in terms of the relative position of the individual antennae in a phased array translate into a blur of meter- scale at ranges of over 200 miles. Current systems do not take the effects of these vibrations into account, although some efforts are likely already made to mitigate large-scale vibrations.

These vibrations cannot be, practically, eliminated entirely. The solution to this problem is to outfit the array with a series of pulsating LEDs which would be readily powered by the plentiful energy in the individual prongs of the array. Four LEDs affixed, respectively to the North, South, East and West sides of the prongs would emit light in four directions so as to constantly measure the distance between a prong and the neighboring prongs. Emitted light would be readily detected by the antennae through the photoelectric effect relative to the timing of pulses of energy routed through the prongs.

Provided proper calibration and mutually averaged one-way measurements, it would not be necessary for a reflected return to be measured in order to ascertain distance as the distance between the prongs under condition of zero vibration could be ascertained after the manufacturing process. It would only be necessary to know the precise time at which energy passed through a prong and the time at which light struck the neighbors to know the distance the prong was from the neighbors at the time in question provided that the neighbors are making their own mutual measurements. This may be termed *mutually averaged unidirectional interferometry.* This information would form

the basis of an algorithmic correction of blurry return data coming from objects at great range.

The blurring effect caused by these vibrations is likely greatly underestimated by system designers and operators as the use of large clusters of antennae introduce an aggregated error which is much greater than the error introduced by any two prongs in isolation.

Once these vibrations can be accounted for, they may even be exploited. As the relative position of the prongs would determine the precise range of paths of the beam, if an object beyond the usual maximum range of the system appeared to be; over nanosecond timescales; appearing and disappearing depending upon the proximity of the prongs (and thus the direction of the beam) it could be interfered that an object must exist somewhere in the space between the outer beam parameter at prong perigee and prong apogee. This would extend the useful range of the system by a substantial margin.

As a bonus, when used in conjunction with orbital platforms, if the orbital platforms were sufficiently numerous, particular structures of electromagnetic energy would likely be able to foster the detection of both positive and negative energetic discrepancies cast by even stealthy platforms. Sufficiently fine control over phased array antennae and knowledge of the relative prong spacing under dynamical conditions i.e. in the presence of unavoidable vibrations could enable the system operation to use the phased array emissions to induce a speculative state in RADAR Absorbing Structures within the detected aircraft which may be termed *electron counterflow induced broadcast* in which striking an ordinarily energy-absorbing mesh with phase-opposed EM waves would force the generation of modified EM by the mesh as if it were an antennae, turning the RAS structure into an antennae which would make it plainly visible, likely, to both the X-Band receiver unit as well as orbital detectors. Although this is ordinarily prevented through structuring which permits electron flow only in a single direction (photon generation generally requires opposing electron flows,) these effects can be overcome under the circumstance that phase-opposed energy strikes simultaneously and in close physical collocation. Bringing such an effect about would likely entail steering two beams from the same array toward the same physical point but in such as manner that phase could be predicted to be opposed when the destination is reached. As information concerning range would be unknown for an undetected object random permutations of phase would have to be attempted for this technique to be used to bring about an initial detection.

Therefore, this additional mode of usage would most likely find its greatest application in ascertaining the three-dimensional structure of not only stealthy aircraft (which tend to appear on RADAR as spheres under ordinary circumstances,) but information concerning the internal structure of the RAS meshes.

Conclusion

Active measurement of antenna spacing and reflexive algorithmic correction of received returns can, therefore, greatly enhance the effectiveness of Phased Array/X-Band RADARs at reasonably low cost.